GROUND WATER QUALITY VARIATIONS IN SAHARANPUR DISTRICT(U.P.)

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ABSTRACT

The quality of groundwater is of great importance in determining the suitability of a particular ground water for a certain use (public water supply, irrigation, industrial application,cooling heeting, power generation,etc.). The quality of groundwater is the resultant of all processes and reactions that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged by a well or spring. Therefore, the quality of groundwater varies from place to place, with the depth of water table, and from season to season and is primarily governed by the extent and composition of dissolved solids in it. The kind and concentration of dissolved solids depends upon source of salts and sub-surface environment.

In the present paper, the results of the analysis of ground water sample from shallow unconfined aquifers of Saharanpur district have been presented. Temporal variations of groundwater quality have also been marked.

The main use of these shallow wells is for agriculture and domestic pruposes. Therefore, suitability of water for irrigation and drinking purpose has been tested with reference to available standards. The results indicate that the quality of ground water in the area under study is in general good for irrigation as well as for drinking purposes. There is not much variation in the quality of water in premonsoon and postmonsoon seasons due to less rainfall.

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INTRODUCTION

In nearly every corner of the globe, man is making increasing demands upon his surroundings and thereby altering his own natural environment and that of the other organisms living with him on the earth. The demands are increasing not only because of the rapid growth of human population but also due to the increase in the living standard.

The minerals carried in water, determine its usefulness for various purposes. Presence of some ions, beyond a certain limit, may make water injurious for irrigation, drinking or industrial purposes. For example, high levels of nitrate (More then 45 mg/L) may cause methenoglobinemia or blue baby disease, and fluoride more than 1.5 mg/L can cause dental, skeletal and non skeletal manifestations. High levels of Na^+ can be hazardous to the agricultural activities. Hence, it becomes necessary to monitor the groundwater quality in an area to assess its suitability for various uses.

Ground water quality variation problem can be understood only by the regular monitoring of quality of water. In Western Uttar Pradesh rapid industrial and agricultural growth has taken place during the last two decades. This is likely to become manifold in near future with increasing industrialisation particularly in areas like Saharanpur where the necessary industrial nucleus already exists. Therefore, it was proposed to take up monitoring work in district Saharanpur(Fig.1). Samples from 22 dug wells were collected and analyse

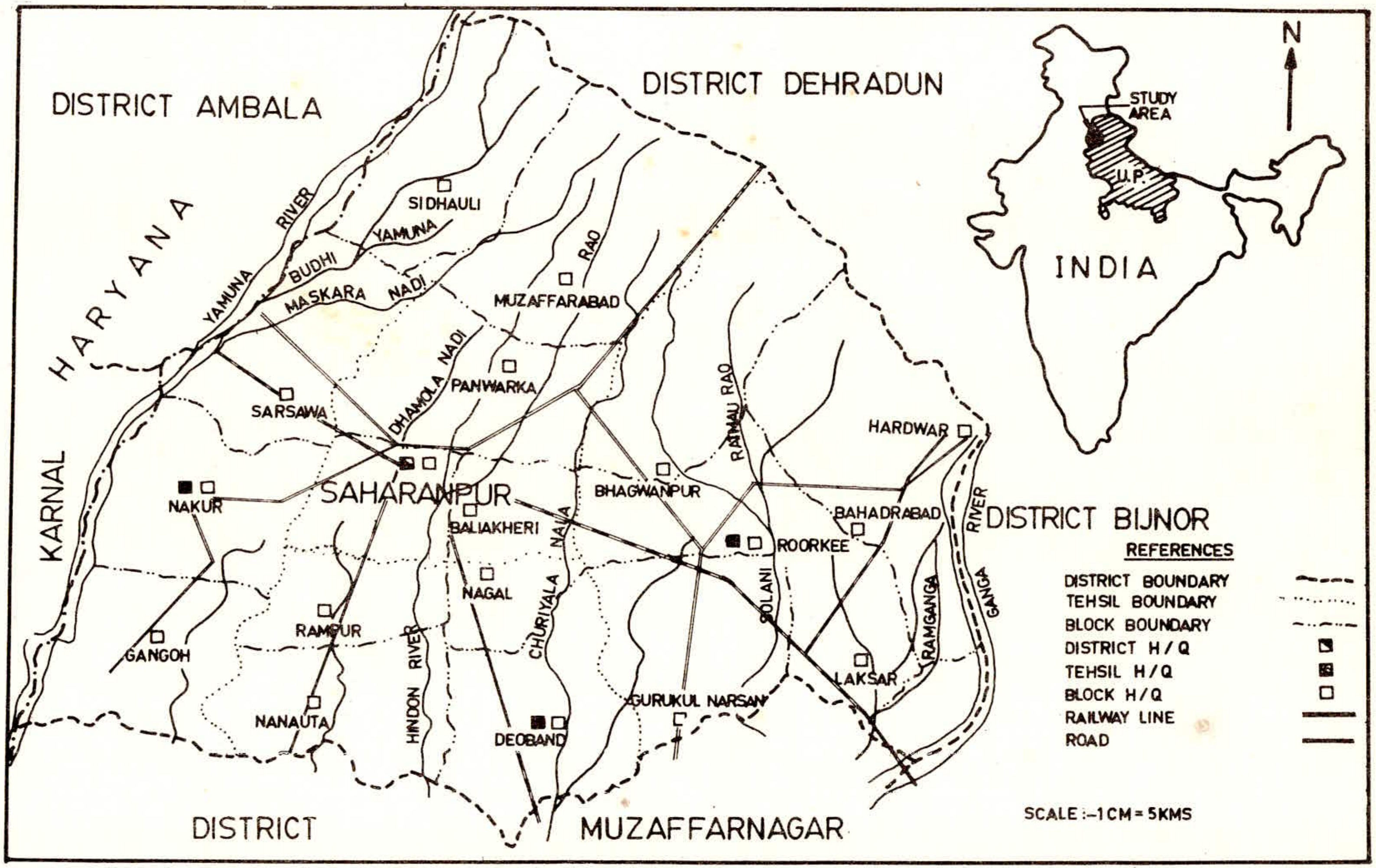

FIGURE 1 - INDEX MAP OF DISTRICT SAHARANPUR

STATUS OF GROUND WATER QUALITY IN INDIA

Ground water is protected by the soil cover. Nevertheless, its quality is subject to change mainly as a result of human activities on the overlying cover. Discharge of untreated effluents from the industrial units and disposal of solid wastes on the land results in percolation and leaching, and eventual pollution of ground water. Excessive use of fertilizers in some areas has resulted in high concentration of several constituents in ground water. The problem of ground water pollution in several parts of the country has become very acute.

Deterioration of ground water quality is often a slow and insidious process. The time lag between pollution discharge at land surface and the percolation of pollutants to ground water may be several years or decades, it may not be usable as drinking water source for decades and possibly centuries.

Some cases are cited below where severe pollution of ground water has been observed (Tyagi, 1987, Kakkar 1988).

a) <u>Industrial Pollution</u>

- Coloured ground water incidences in Jodhpur and Pali (Rajasthan) and Jetpur and Rajkot (Gujarat) due to seepage of effluents from textile dye industries, and in Jalundhar(Punjab) and Dehradun(Uttar Pradesh) due to a nearby distillery.

- High levels of nickel, zinc and lead have been reported in Coimbatore, Udaipur and Khetri(Rajasthan) mines respectively.
- High concentration of chromium have been found in ground water from Ludhiana(Punjab), Faridabad(Haryana), and Kanpur and Varanasi(U.P.).
- Anamolously high values of lead, zinc, copper, lithium, molibidinum have been found in some dug wells in U.P. and high concentration of cadmium in Kanpur and Delhi have also been located.

b) Agricultural Pollution

- Fertilizers are applied for almost all crops and vary with crop type, soil conditions and irrigation practices. Pesticides, insecticides, herbicides, fungicides and other chemicals are used to control organisms harmful for the crop. Other sources of pollution are wastes from animals in the rural area.

c) Miscellaneous Sources of Pollution

- There are some other sources of ground water pollution, including seepage from septic tanks, cesspools and leaching pits of low-cost latrines. In West Bengal and Gujarat areas, saline water intrusion into ground water has been reported.

d) Natural Sources of Pollution

- Ground water in several parts of Rajasthan, Gujarat, Punjab, Haryana, Delhi and many other areas in moderately to highly saline. In parts of Rajasthan, Southern Punjab, Haryana, Uttar Pradesh, Gujarat, Andhra Pradesh, Tamil Nadu and Karnataka, high concentrations of fluoride in ground water have been reported and there are cases of mottling of teeth, dental and skeletal fluorosis at these places. High concentration of iron in ground water has also been reported from several areas, particularly in West Bengal, North Eastern States and Kerala.

DESCRIPTION OF THE AREA

The area under study is part of the indogangetic plains and lies between latitude 30°26'N - 29°34'N and longitude 78°11'E - 77°6'E in the Saharanpur district of Uttar Pradesh (India) (Fig.1).

Saharanpur is one of the important towns of Uttar Pradesh. In western U.P. rapid industrial and agricultural growth has taken place during last two decades. This is likely to become manifold in near future particularly in areas like Saharanpur where the necessary industrial nucleus already exists. A variety of industries already have been set up in the district such as paper, textile, sugar, food-processing, small scale steel industries and cottage industries etc.

i) Physiography

Physiographically the area is generally flat except Siwalik hills in the north and north east. The area is devoid of relief features of any prominence except from deep gorges cut by nalas and rivers flowing through the area. The district is bound by river Yamuna in the west and river Ganga in the east.

ii) Drainage

Regarding the drainage of the area, the rivers generally flow from north to south. These rivers during most of the non-monsoon season carry water drained into them from ground water storage. Some of the important rivers of the district are, the Ganga, Yamuna, Hindon, Krishni and the Kali (West). Apart from these rivers, the western Ganga canal and Eastern Yamuna canal also drain the area.

iii) Climate and Rainfall

The climate of the district Saharanpur as that of the greater part of Indian subcontinent is characterised by moderate type of subtropical monsoonic climate. In generally, the average normal monsoon rainfall in the district is about 485.6 mm. The temperature ganges from $8^{o}c$ in winter to 40^{o} in summer. Major part of the rainfall (about 75%) is received during the monsoon period. It has been observed that the rainfall is heaviest in the northern region of the district, close to foot hills of Himalayas and becomes lesser southward.

iv) Geology of the Area

The area under study is a part of west Indogangetic plain which is mainly composed of Pleistocene and subrecent alluvium brought down by river action from the Himalayan region. In other words alluvium is made up of recent unconsolidated fluviatile formations comprising of sand, silt, clay and kankar with occasional beds of gravel. The deposits of sand beds of varying thickness are the main source of ground water in the area.

v) Geohydrology of the Area

The groundwater condtions in all alluvial parts are considerably influenced by the varying lithology of the subsurface formations. As the general fluviatile nature of deposits of Indogangetic plains it has been observed that the strata exhibit great variation both laterally and vertically. The main source of water which sustains groundwater body in fine to coarse grained sands is rainfall. Other sources of groundwater replenishment are infiltration from rivers, canals and return flow from irrigation, and inflow from the neighbouring areas.

The most common groundwater structures in the area are shallow and deep tubewells. Dug wells are also used as source for drinking water as well as irrigation, but to a lower extent.

Based on the lithological logs and water table fluctuation data two types of aquifers have been delineated in the area (Singh et al,1979). The upper one is the shallow unconfined aquifer which generally extents to depths around 25 m. The deeper aquifers are confined to semi-confined in nature and located at depths around 30 to 140 m, below ground level separated by three to four aquifers at average depths of 30 m to 55 m, 65 m to 90 m and 120 m to 140 m. Water table contours in the area indicate the southward trend of ground water flow both in unconfined aquifers and confined aquifers.

METHODOLOGY

i) Sampling

In the present study twenty two wells covering the Saharanpur district were choosen. Sampling was carried out in the months of June 1987 (Pre-monsoon) and Nov.1987 (Post-monsoon).

The samples were collected by dip (or grab) sampling method. Depth integrated samples were collected by lowering the container in the open wells. The samples collected , were stored in clean plastic bottles fitted with screw caps. About two litres of water sample was collected. Another one litre was acidified (pH<2) with HNO_3 and stored in separate bottle for analysis of metal ions which may change before the samples reach the laboratory.

ii) Water Quality Parameters

During the present study the chemical properties and the constituents of water analysed are, pH, specific conductance (EC), colour odour, Hardness, Alkalinity (carbonates and bicarbonates) temperature and major cations and anions.

iii) Methods of Analysis and Equipment Used

The laboratory of the Institute is capable of analysing the basic parameters for water and waste water. However, for the measurements of some parameters such as pH, conductance and temperature, the protable water testing Kit was used. The list of essential equipment used and methods of analyses are presented in Table 1. The preliminary studies to get acquainted with the field equipment was carried by the project team. Testing of the equipment and, preliminary calibrations have been prepared and used for each determinant.

TABLE-1: ANALYSIS METHODS AND EQUIPMENT USED.

S.No.	Parameter	Analysis method	Equipment used
1.	Temperature	Thermometric	Portable kit (Naina Model NPC 358D)
2.	pH	Electrometric	"
3.	Conductance	Wheatstone bridge	"
4.	Turbidity	Photometric	Turbidimeter(High Model 16800)
5.	Alkalinity	Titrimetric	Digital titrators(Hach)
6.	Hardness	Titrimetric	Digital titrators(Hach)
7.	Ammonia-nitrgen	Nesslenization	Spectrophotometer(Hach) DREL/5 System)
8.	Nitrate-nitrogen	Cadmium-reduction	"

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9.	Nitrite-	Diazotization	Spectrophotometer(Hach) DREL/5 System)
10.	Chloride	Mercuric nitrate	Digital titrator(Hach)
11.	Sulphate	Turbidimetric	Spectrophotometer(Hach DREL/5 System)
12.	Phosphate	Ascorbic acid	"
13.	Fluoride	SPADNS method	"
14.	Iron	1,10 phenan- throline	"
15.	Sodium	Flame emission	Flame photometer (Toshniwal Model RL 01. 02)
16.	Potassium	Flame emission	"
17.	Calcium	Titrimetric	Digital titrator(Hach)
18.	Magnesium	Titrimetric	Digital titrator(Hach)

RESULTS AND DISCUSSION

The quality of groundwater as determined by its chemical and biological constituents, its sediment contents and its temperature is of great importance in determining its suitability for a certain use, such as public water supply, irrigation industrial application etc. The quality of water is as much important as its quantity. Groundwater quality is the resultant of all processes and reactions that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged by a well or spring. Generally higher proportion of dissolved constituents are found in groundwater than in surface water because of greater interaction of groundwater with various materials in geologic strate.

In the present study, groundwater quality variation at different places, (Fig.2) in pre-monsoon and post-monsoon period, of the shallow unconfined aquifers was carried out. The results of the chemical analysis of groundwater samples are given elsewhere (NIH,1988).

The Piper diagram described above is useful for visually describing differences in a major ion chemistry in ground water flow system.

The chemical analysis data of all twenty two samples for major ions are plotted on the trilinear diagram for both the seasons (Fig.3 & 4). The position of all points (except one, that of Bahadrabad) represents that the waters analysed are rich in Ca + Mg and $HCO_3 + CO_3$.

The water of Bahadrabad lies in field in which non of the cations dominate.

A soil high in exchangeable sodium is very undesirable for agriculture because the soil can become deflocculated and tends to have relatively impermeable crust. The condition is prompted by waters of high SAR and is reversed by waters containing a high proportions of Ca and Mg (Piper,1944). The SARR is calculated from the formula.

$$SAR = \frac{Na.}{\sqrt{\frac{Ca + Mg}{2}}}$$

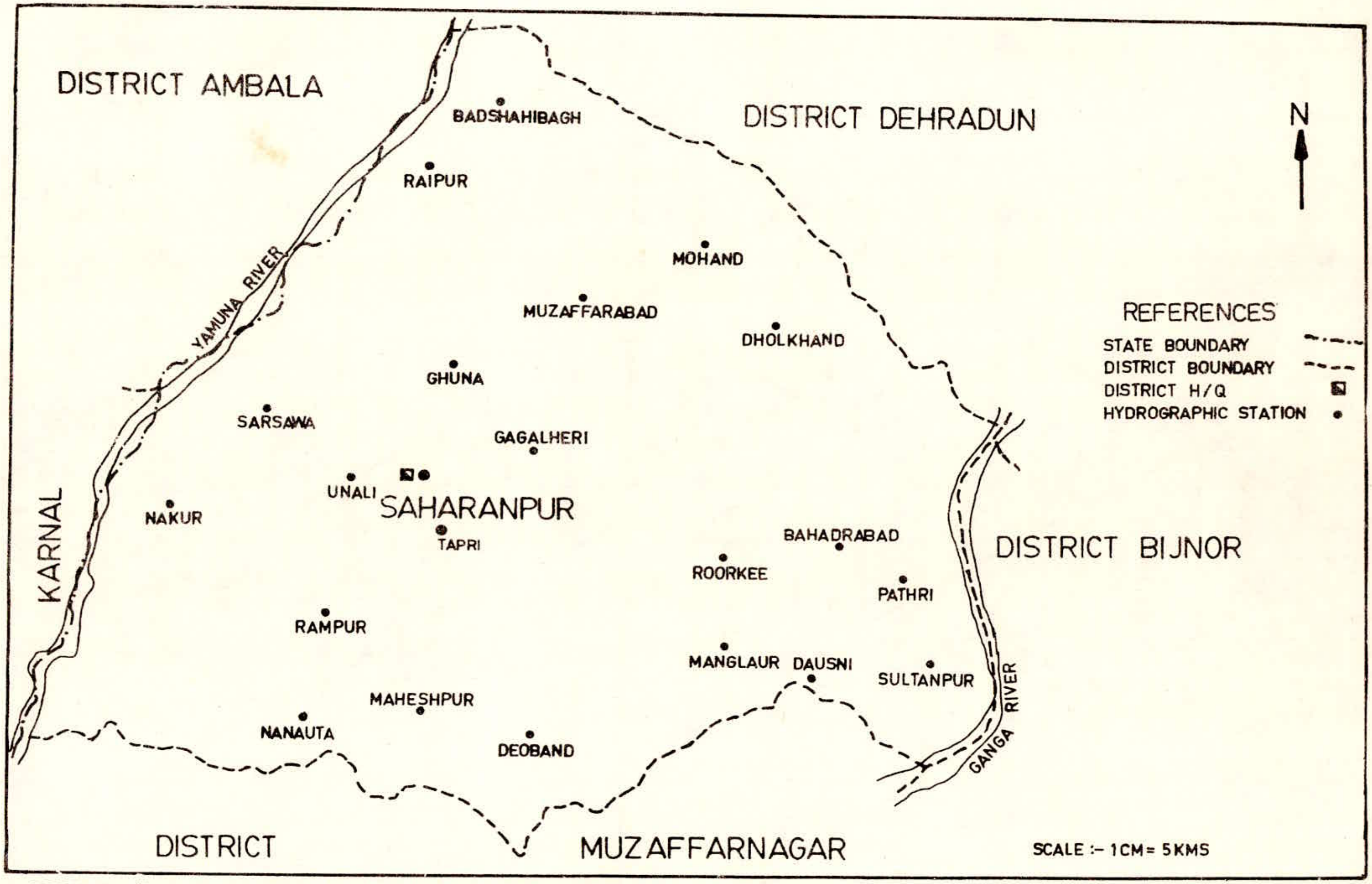

FIGURE 2,- MAP SHOWING GROUND WATER SAMPLING POINTS

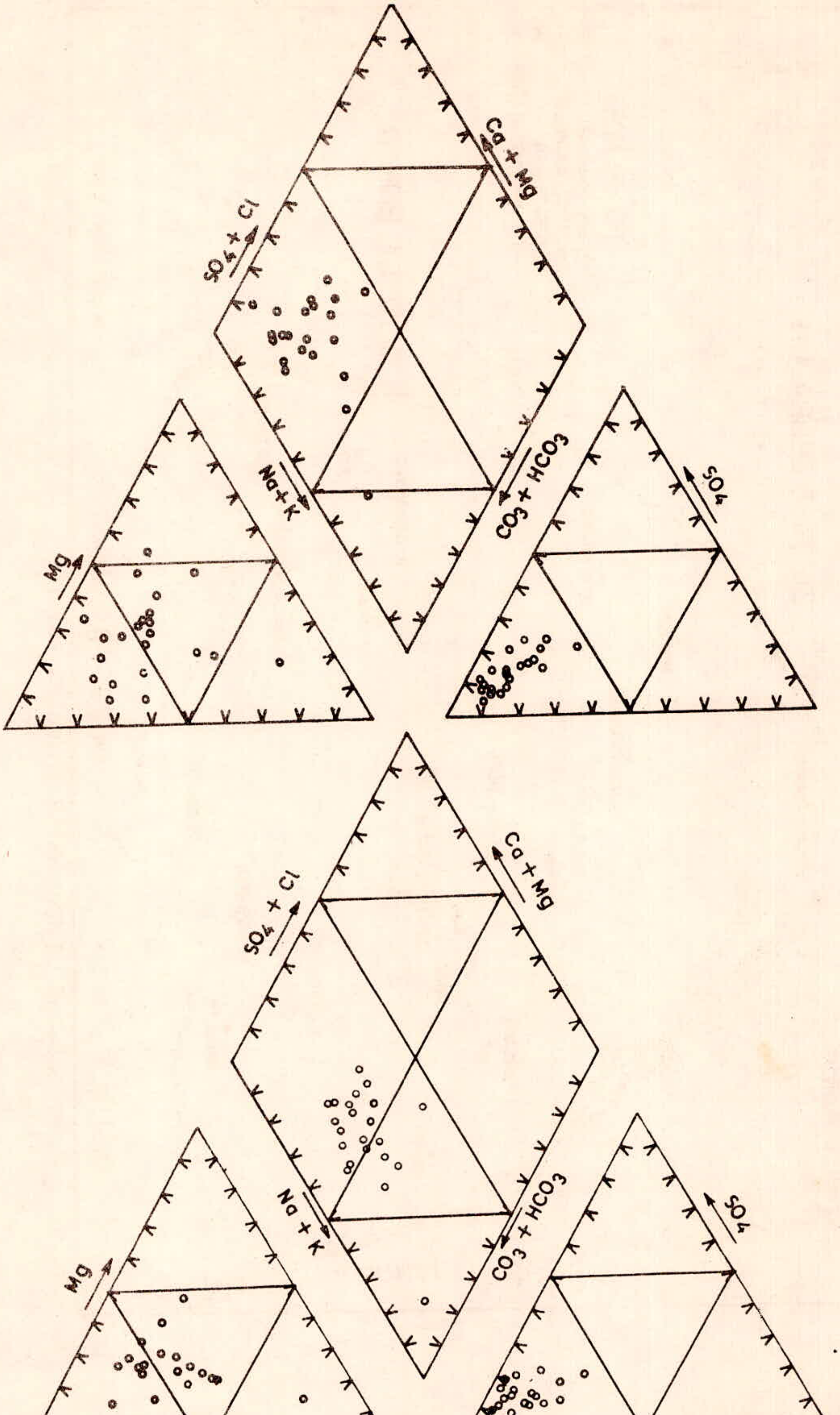

Fig.3&4 PIPER TRILINEAR DIAGRAM PRE & POST MONSOON.

The values of SAR in the water samples of the area varies from 0.275 to 5.882 in pre-monsoon and from 0.87 to 5.311 in the post-monsoon period.

The U.S. Salinity laboratory, Department of Agriculture, U.S.A. recommended the SAR as basis for classification for agriculture uses as given below:

SAR	WATER CLASS
< 10	Excellent
10 - 18	Good
18 - 26	Fair
> 26	Poor

As per as the suitability of water for domestic purposes is concerned, the water is good for drinking, as the concentration of various parameters is within the acceptable limits laid by B.S.I. SAR contours are shown in Fig.5&6.

CONCLUSIONS

The groundwater problems are more acute in the areas which are densely populated, are thickly industrialised and have shallow groundwater table. Keeping in view these factors, the National Institute of Hydrology undertook to study the groundwater pollution in the dug wells in the thickly polluted district of Saharanpur. This area is also having number of industries and agricultural activities are at the peak.

The paper presents an analysis of the groundwater quality data obtained on the water samples from 22 open wells in the Saharanpur district. Mostly these open wells tap only

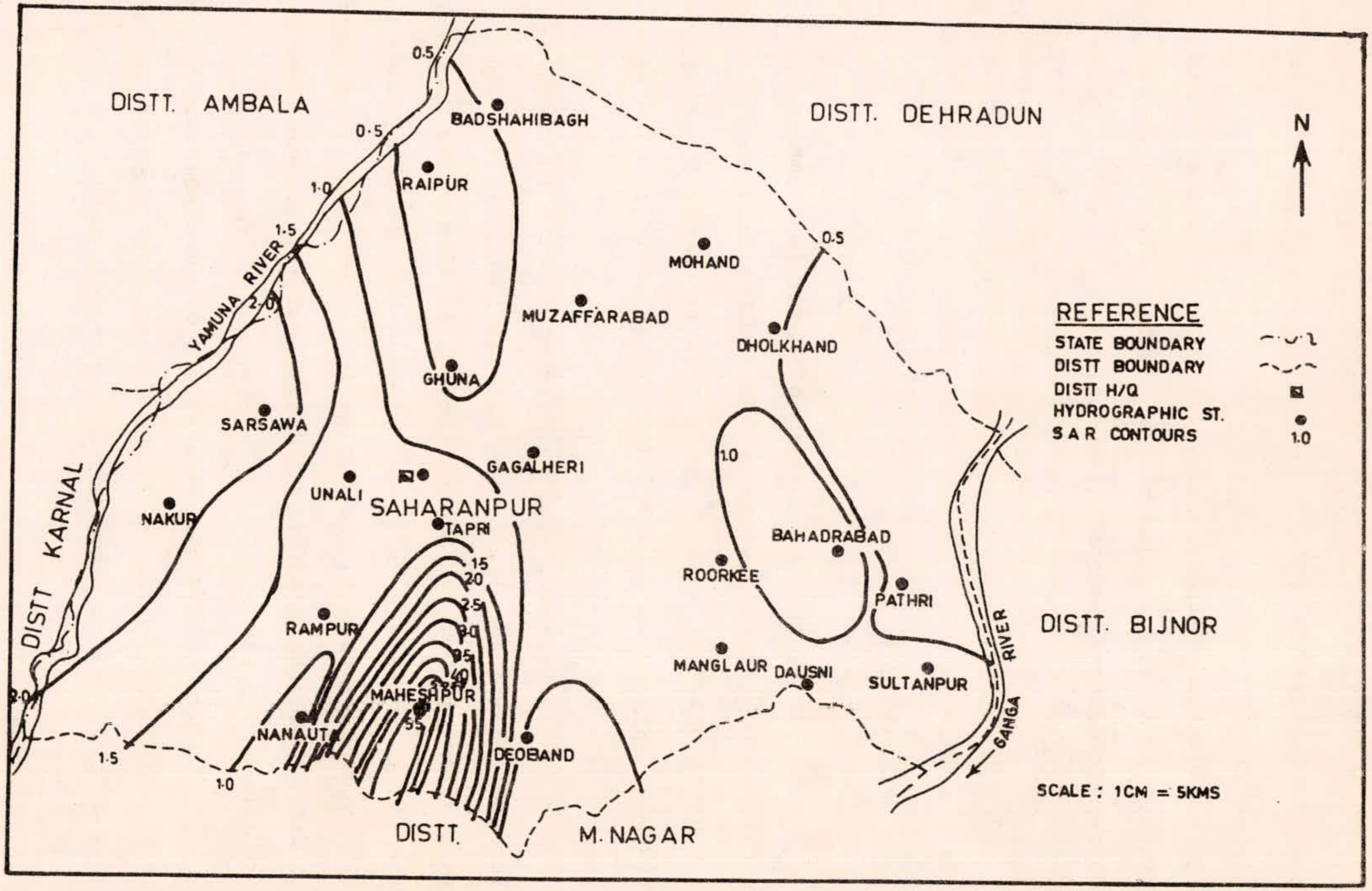

FIG. 5 SAR CONTOUR MAP FOR PRE-MONSOON PERIOD (1987)

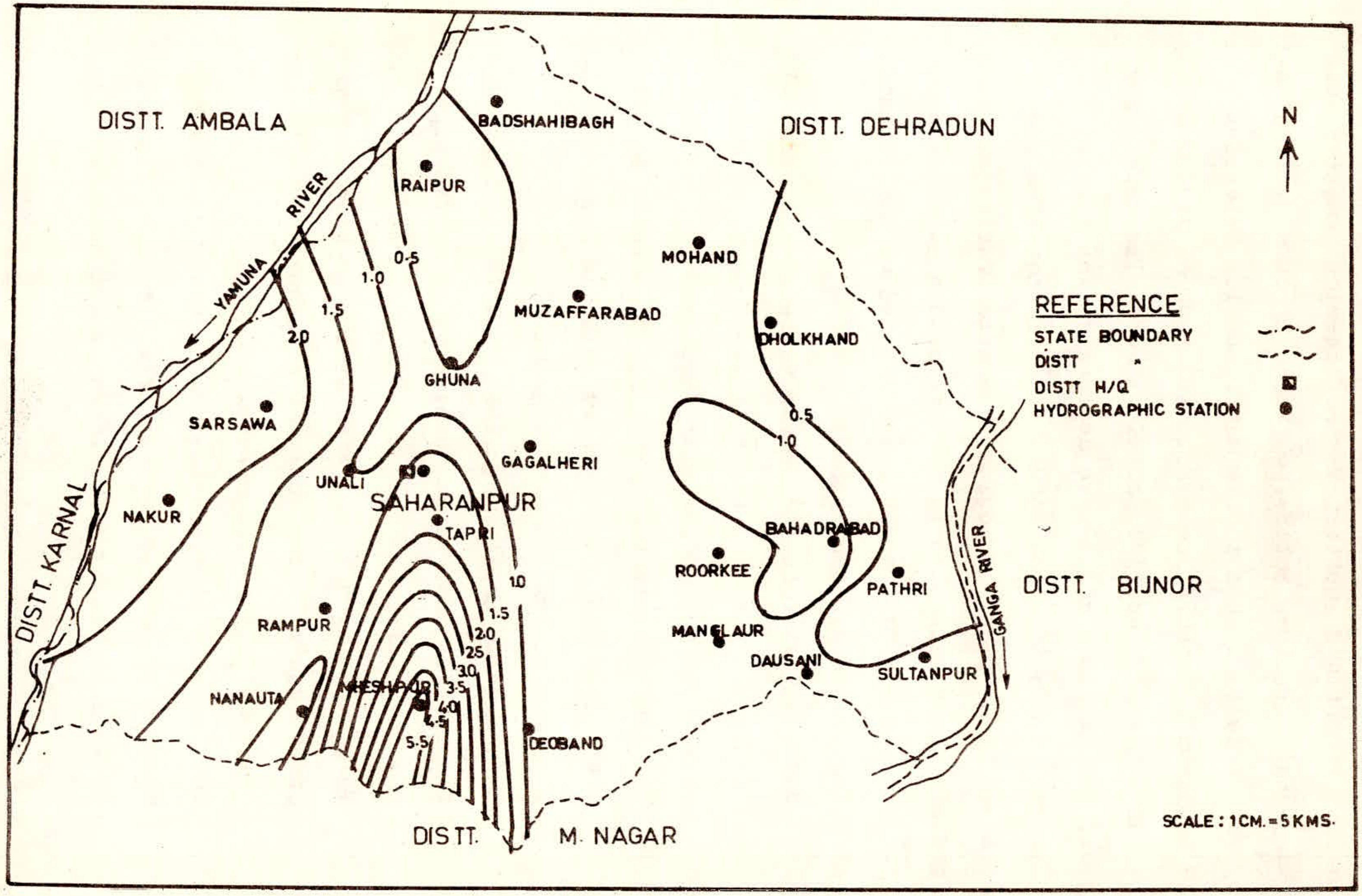

FIG. 6 S A R CONTOUR MAP FOR POST-MONSOON PERIOD (1987)

the shallow unconfined aquifer. Various chemical constituents like pH, total dissolved solids,temperature, turbidity, alkalinity etc. were estimated in the water quality laboratory of the Institute. Further, temporal variation of groundwater quality at these 22 specified locations were also marked and analysed. The problems zones were delineated and spatial distribution of groundwater contamination in the area was attempted to be mapped. The sodium absorption ration was also computed. This was attempted in the premonsoon season and the post monsoon season. This was further related to the suitability of water for irrigation purposes.

The study is focussed on the variation of groundwater quality in the area and the following points emerged from the analysis of the groundwater samples.

1. The chemical nature of shallow groundwater in the area shows that the water is suitable for irrigation projects as well as public supply.
2. The water in shallow aquifers is rich in bicarbonates and alkaline earth metals, as seen from pipe trilinear diagram.
3. Polluted Hindon River water is interacting with the ground water in the south of Saharanpur causing the deterioration of groundwater quality.
4. The lowering of electrical conductivity in the postmonsoon season, in general, reflects the dilution of ions in groundwater. There is not much variation

in quality due to the failure of monsoon in 1987.

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